

10/644,944

filed 8/19/03

DOCKET No.

ABE1P002

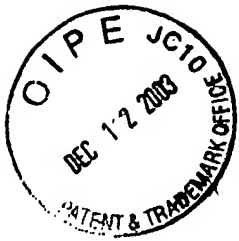
U.S. PATENT APPLICATION  
FOR  
CONTINUOUS PRICE OPTIMIZATION SYSTEM,  
METHOD AND COMPUTER PROGRAM PRODUCT  
FOR SATISFYING CERTAIN BUSINESS  
OBJECTIVES

INVENTOR: John R. Abe

SILICON VALLEY IP GROUP, P.C.

P.O. Box 721120

SAN JOSE, CA 95172



# CONTINUOUS PRICE OPTIMIZATION SYSTEM, METHOD AND COMPUTER PROGRAM PRODUCT FOR SATISFYING CERTAIN BUSINESS OBJECTIVES

## FIELD OF THE INVENTION

The present invention relates to computer-implemented system that continuously  
5 optimizes the price for a supplier so as to meet certain business objectives.

## BACKGROUND OF THE INVENTION

A supplier who competes in a market with one or more competitors is faced with  
10 the challenge of continuously pricing their goods and services. If a supplier understands  
the market's responsiveness to price as well as the supplier's cost, a supplier can  
determine the optimal price that ensures meeting one or more of the following business  
objectives; a) Maximizing revenue, b) Maximizing Gross Profit, c) Maximizing  
Earnings Before Income Tax, d) Market share, e) Factory utilization, and more. Ideally,  
15 the supplier's understanding of the market will continuously update itself to reflect  
competitor's changes in pricing as well as shifts in supply and demand.

Prior art has limitations that not only prevent a supplier from making an initial  
useable estimate of the optimal price, but also from making an accurate update of the  
20 optimal price. The limitations stem from inaccuracies and potentially incorrect  
assumptions associated with the demand or yield curve, which depicts the relationship  
between quantity and price. These inaccuracies are the result of one or more of the  
following problems; a) Limited span in sales order data in which to build the demand

curve, b) Lack of statistically relevant sales order data, c) Lack of market relevant sales order data, d) Implicit assumption that the historical and future sales environments remain the same, e) Lack of a rapid method for assessing whether a new optimized price is required as a result of a shift in market demand or pricing, f) Lack of a method of  
5 rapidly updating the optimized price calculation.

The demand curve is typically constructed using the supplier's historical sales order data, which limits the extent and completeness of the demand curve. For example, if the supplier behaves as the "low price leader", the sales order data can only  
10 be used to create a demand curve reflecting how the market responds to low pricing.

The demand curve should depict the market's responsiveness to all pricing scenarios, not just those scenarios previously employed by the company. As a result of using a demand curve constructed using a limited span of sale order data, it is not likely  
15 that the optimum price can be determined.

Another challenge in constructing the demand curve is the lack of statistically relevant data. Frequently, there are pieces of sales data which conflict. An example is that one customer was willing to pay \$2.23 each for 10,000 units. Another customer, in  
20 the identical customer group may demand 11,500 units for \$2.23 each, a 15% difference in quantity. This situation is not unusual, especially for opaque markets where one buyer does not see what other buyers are paying and therefore facilitates a supplier charging different unit prices for the same goods or services. The prior art attempts to resolve this situation through averaging algorithms and requires sufficient sale order  
25 data for statistical relevance. The challenge is that there is seldom-sufficient data to build a statistically relevant demand curve.

Yet another challenge with the prior art is that even if the demand curve is statistically relevant, it is not market relevant. Statistical relevance can be assured through a large enough set of sales orders. However, collecting a large set of sales orders may necessitate waiting long periods of time to allow a sufficient number of orders to be accumulated for statistical relevance. During the long collection period, the market may have changed considerably in its responsiveness to pricing. So while the demand curve may have statistical relevance, it is meaningless because it is based on data too old for market relevance. As a consequence, determining an optimum price based on a dated demand curve is unlikely.

In the prior art, there is an implicit assumption that the historical sales and future sales environments are identical. For example, if the derived demand curve indicates that 10,000 units were sold when the price was \$3.25, the expectation going forward is that the supplier will again sell 10,000 units at \$3.25. The implicit assumption is that the overall economic environment, the supplier's approach to marketing, and selling methodology has remained the same. Rarely do the economic environment, the supplier's marketing, and selling methodologies remain intact for any length of time. As a consequence, the validity of the demand curve is questionable and its usefulness in doubt.

Without a representative demand curve, it is impossible to determine an optimum price that ensure meeting one or more of the following business objectives; a) Maximizing revenue, b) Maximizing Gross Profit, c) Maximizing Earnings Before Income Tax, d) Market share, e) Factory utilization, etc.

Even if prior art could overcome the aforementioned issues associated with the span of sales order data, statistical relevance, market relevance, and the accommodate changes in selling methodologies, prior art still must overcome the final issue of rapidly

determining when market shifts in pricing and demand necessitate updating the demand curve. Without a method for rapidly determining when the demand curve is no longer representative of the market's responsiveness to price, a supplier will continue under the presumption that the current price is optimal when the market shifts have necessitated  
5 that a new optimal price is needed.

In accuracies and poor assumptions aside, once a demand curve is created, the supplier can make a determination of how to price their goods and services in order to satisfy certain business objectives. With an understanding of the relationship between  
10 quantity and price, an income statement, as well as additional metrics, can be constructed for each price through the following steps; a) Calculation of revenue by multiplying the price and quantity, b) Determination of the cost-of-goods by multiply the quantity and unit cost at that quantity, c) Calculation of gross profit by subtracting the cost-of-goods from the revenue, d) Determining the sales and general administration  
15 costs, e) Calculating the earnings before income tax by subtracting the sales and general administration costs from the gross profit, f) Calculation of market share by dividing the quantity by the total quantity sold by all suppliers, and e) Calculating factor utilization by dividing the units sold by the capacity of the factory for that product.

20 Once the income statement and additional metrics are calculated for each price, the optimum price can be selected to satisfy various business objects. For example, the supplier may wish to optimize pricing to maximize revenue. To identify the optimum price that maximizes revenue, the income statements are searched to identify where the revenue is maximized and the associated price extracted.

25

In addition to optimizations with one objective in mind, optimizations are possible that maximize the multiple business objectives. For example, the supplier may wish to optimize pricing to maximize revenue and gross profit. In this example, the

income statements are searched for the price at which revenue is maximized and the price at which gross profit is maximized. The supplier then selects a price between the maximum gross profit and revenue price that represents the best tradeoff between these two business objectives.

5

**DISCLOSURE OF THE INVENTION**

A computer-implemented method, system and computer program product are provided for utilizing feedback in generating an optimal price. In use, an optimal price is generated. Next, a result of utilizing the optimal price is identified. A reaction may then be carried out based on the result.

**BRIEF DESCRIPTION OF THE DRAWINGS**

5       **FIG. 1A** is a diagram of a general-purpose computer system with principal elements used in one embodiment.

**FIG. 1B** is a diagram of the processing flow between the major processing components.

10       **FIG. 2** is an input menu on the display device.

**FIG. 3** is a second input menu on the display device.

**FIG. 4** is a flow chart illustrating the input of data.

15       **FIG. 5** is the second flow chart illustrating the input of data.

**FIG. 6** is a flow chart illustrating the calculation of standard deviation ratios and assignment of the Mean Price Estimate.

20       **FIG. 7** is a flow chart illustrating the beginning of the optimization loop.

**FIG. 8** is a flow chart illustrating the assignment of optimization variables.

25       **FIG. 9** is a flow chart illustrating the assignment of optimization variable and initiation of the Mean Price Error Index Loop.

**FIG. 10** is a flow chart illustrating the assignment of optimization variables and the calculation of the lower portion of the Frequency Distribution Array.



**FIG. 11** is a flow chart illustrating the continued creation of the upper portion of the Frequency Distribution Array.

5           **FIG. 12** is a flow chart illustrating the smoothing of the Frequency Distribution Array data.

**FIG. 13** is a flow chart illustrating the continued smoothing of the Frequency Distribution Array data.

10           **FIG. 14** is a flow chart illustrating the integration of the Frequency Distribution Array and the determination of the Expected Results Array

15           **FIG. 15** is a flow chart illustrating the continued determination of the Expected Results Array.

**FIG. 16** is a flow chart illustrating the continued determination of the Expected Results Array.

20           **FIG. 17** is a flow chart illustrating the search for Mean Price Estimate plus and minus an uncertainty in the Expected Results Array.

**FIG. 18** is a flow chart illustrating the continued search for Mean Price Estimate plus and minus an uncertainty in the Expected Results Array.

25           **FIG. 19** is a flow chart illustrating the continued search for Mean Price Estimate plus and minus an uncertainty in the Expected Results Array.

**FIG. 20** is a flow chart illustrating the search in the Expected Results Array for the price that yields the maximum income. –

5      **FIG. 21** is a flow chart illustrating the search in the Expected Results Array for the price and corresponding index that yields the maximum income and the search in the Expected Results Array for the price that yields the maximum profit.

10      **FIG. 22** is a flow chart illustrating the continued search in the Expected Results Array for the price and index that yields the maximum profit.

**FIG. 23** is a flow chart illustrating the determination of price so that the objectives of maximum income and profit are balanced.

15      **FIG. 24** is a flow chart illustrating the continued determination of price so that the objectives of maximum income and profit are balanced.

**FIG. 25** is a flow chart illustrating the assignment of variables if the objective is to maximize income.

20      **FIG. 26** is a flow chart illustrating the assignment of variables if the objective is to maximize profit and store the optimal price in the Expected Results Array.

25      **FIG. 27** is a flow chart illustrating the determination of the Error Lookup Array contents.

**FIG. 28** is a flow chart illustrating the continued determination of the Error Lookup Array contents.

**FIG. 29** is a flow chart illustrating the continued determination of the Error Lookup Array contents, completion of the optimization loop, and test to determine if price optimization should be updated.

5           **FIG. 30** is a flow chart illustrating the calculation of Actual Wins for a given period.

**FIG. 31** is a flow chart illustrating the determination of whether Actual Wins is within a tolerable limit.

10

**FIG. 32** is a flow chart illustrating the selection of a New Mean Price.

**FIG. 33** is a flow chart illustrating subroutines that extract Competition Counts and Actual Wins from legacy systems.

15

### **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

The following description is present to enable one of ordinary skill in the art to  
5 make and use the present embodiment and is provided in the context of a patent  
application and its requirements. Various modifications to the illustrated embodiment  
will be readily apparent to those skilled in the art and the generic principles herein may  
be applied to other embodiments. Thus, the present embodiment is not intended to be  
limited to the embodiment shown but is to be accorded the widest scope consistent with  
10 the principles and features described herein.

As shown in **FIG 1**, a system includes one input/display device **100** or multiple  
input/display devices **102** such as a computer workstation that a user enters commands,  
inputs data, and views computed results; one or more legacy software applications **126**  
15 that are used to issue prices, record quotes, and sales orders; a connection to the  
Internet/WAN/LAN **104** that uses TCIP protocol; a firewall **106**; a server or other such  
computing device **108** consisting of an application server **110**, a processor **112**, random  
access memory **114**, and disk storage **116**.

20 The memory **114** and disk **116** store a Frequency Distribution Engine **118** that  
calculates the number of offers for the subject goods and services that the user believes  
competitors are offering in a particular market. In addition the memory **114** and disk  
**116** store the Probability of Win Engine **120**, which calculates the probability that the  
user will receive a sale when the subject goods and services are priced at a specific  
25 value, and a Expected Results Engine **122** that calculates the anticipate revenue and  
gross profit for each price. The Legacy System Interface translates sales order and Offer  
Opportunity data from the Legacy System(s) **126** to a useable format for the subject  
application.

It will be understood that the described embodiments are embodied as computer instructions stored in memory 114 and executed by processor 112. These instructions can also be stored on a computer readable media such as a floppy disk, CD ROM, etc.  
5 and can also be transmitted via a network such as the internet, an intranet, etc., via a carrier wave embodying the instructions.

**FIG 1B** shows the Menu 130, major processing engines, Frequency Distribution Engine 132, Probability of Win Engine 134, Expected Results Engine 136, Optimization  
10 Update Engine 138, and the Legacy System Interface 140. The Frequency Distribution Engine 132, computes and stores a frequency distribution of prices in a table based received by Menu 130. The Probability of Win Engine 134, computes and stores the probability of a customer purchasing the subject good or service in a table based on the frequency distribution of prices. The Probability of Win Engine 134, adjusts and then  
15 stores the probability of a customer purchase based on the number of competitors received by the Menu 130. Using the adjusted probability of a customer purchase and values received by Menu 130, the Expected Results Engine 136 calculates the units sold, income, cost of goods, gross profit, sales general & administrative expense, and earnings before income tax for each price and mean price and stores the result in a table.  
20 The table created by the Expected Results Engine 136 is searched for the optimum price that optimizes the business objective designated by Menu 130. The Legacy System Interface 140 provides an interface to the user's enterprise resource planning system as well as other legacy systems. Through the Legacy System Interface, values for the Offer Opportunities and Sales Orders are transferred to the Optimization System 108. The  
25 Optimization Update Engine 138, based on the number of Offer Opportunities, percentage difference between the expected and actual wins, determines if a new optimization is required. If an optimization is required, then the actual win rate and the current value for optimized price is used to search an Error Table contained in the

Optimization Update Engine 140 for a new Mean Price value that is used to update the Frequency Distribution Engine 132.

As shown in **FIG 2**, a user who wishes to meet a certain business objective, such as maximizing revenue or maximizing gross profit for a specific good or services is shown a menu 200 on an input/display device. The user enters in parameters that describe the frequency distribution of the number of offers verses price in a designated market as well as the number of competitors. The user enters in an estimated mean price into the Mean Price Field 202, the standard deviation low into the Standard Deviation Low Field 204, the standard deviation high into the Standard Deviation High Field 206, the number of competitors in the Number of Competitors Field 208, the beginning of the frequency distribution on curve in the Low End Field 210, and the end of the frequency distribution curve in the High End Field 212.

The use of a frequency distribution of pricing to estimate the market has distinct advantages over prior art. These advantages are summarized as follows:

- a) Enables a broad and complete estimate of the market that ensures the optimal price can be selected based on business objectives. While prior art can potentially optimize price for a given set of market data, typically that market data is extremely limited in scope.
- b) Eliminates the lack of statistical significance problem of prior art.
- c) Eliminates the potential of lack of market relevance associated with prior art.
- d) Allows the accounting of micro-economic conditions such as oversupply verse demand, undersupply vs. demand, and supply equal to demand that may not be depicted in prior art.

The user continues the configuration of the system by entering the number of offer opportunities that is anticipated to occur in a given time period in the Offer

Opportunities Field **214**, the business objective in the Business Objective Field **216**, the cost-per-unit in the Cost-of-Goods Field **218**, and the SG&A cost in the Sales & General Administration Field **220**.

- 5            On completing the entry on data into the menu **200**, the user switches to the display of the Optimization Update Characteristics by activating the Set Update Characteristics Button **222**.

10           **FIG 3** shows a menu **300** that solicits user input to configure the optimization update characteristics. The menu has fields for the Maximum Error In Estimating Mean Price **302**; the frequency that the optimization should be repeated, Optimization Update **304**; and the Tolerable Error Window For Win Rate **306**. On completion of this menu, the user initiates the optimization by activating the Initiate Optimization Button **304**.

15           **FIG 4** shows the flow chart describing the input of data into the routine that is initiated by activating the Initiate Optimization Button **304**. Input and assignment of standard deviation high to variable Standard\_Deviation\_High **400** is accomplished in **400**. Input and assignment of standard deviation low to variable Standard\_Deviation\_Low **402** is accomplished in **402**. Input and assignment of mean price to variable Mean\_Price\_Panel\_Estimate **404** is accomplished in **404**. Input and assignment of Supplier\_Number **406** is accomplished in **406**. Input and assignment of low end to variable Low\_End **408** is accomplished in **408**. Input and assignment of high end to variable High\_End **410** is accomplished in **410**. Input and assignment of the number of competitors to variable Supplier\_Number **412** is accomplished in **412**.

25

**FIG 5** shows the continuation of the flow diagram describing the input of data into the routine. Input and assignment of offer opportunities to variable Offer\_Opportunities **500** is accomplished in **500**. Input and assignment of the business

objective to variable Sel\_Bus\_Obj 502 is accomplished in 502. Input and assignment of the cost-of-goods to variable Cost\_Per\_Unit 504 is accomplished in 504. Input and assignment of sales, general, and administration expenses to variable SG&A 506 is accomplished in 506. Input and assignment of the maximum error to the mean price estimate variable Price\_Max\_Error 508 is accomplished in 508. Input and assignment of the frequency of optimization update value to variable Optimization\_Update 510 is accomplished in 510. Input and assignment of the Tolerable Error Window For Win Rate to variable Error\_Window 512 is accomplished in 512.

10           **FIG 6** illustrates the calculation of the standard deviation ratios, beginning of the optimization loop, and the assignment of the mean price estimates. The standard deviation low ratio, the ratio of the lower standard deviation to the mean price, is calculated in 600 and assigned to variable Standard\_Deviation\_Low\_Ratio 600. The standard deviation high ratio, the ratio of the upper standard deviation to the mean price, is calculated in 602 and assigned to variable Standard\_Deviation\_High\_Ratio 602. The flag, Flag\_Optimization 604, that determines whether an optimization is conducted is set to 1 in 604. The flag, Use\_New\_Mean\_Price 606, is set to zero in 606, which indicates the user's initial estimate of the mean price estimate should be used rather than the estimate derived by the application. The optimization loop, defined by steps 608 through 3302, begins with a program branch 608. The program branches in 608 based on the value of Use\_New\_Mean\_Price 608. If Use\_New\_Mean\_Price 608 has a value of one, then the program uses a New\_Mean\_Price\_Est 610 derived in subsequent steps. If Use\_New\_Mean\_Price 608 does not have a value of one, then the value the user entered in **FIG 2**, menu 200, field 202 is used.

25

**FIG 7** illustrates the determination of whether the optimization will be conducted or delayed. If Flag\_Optimization 700 is not equal to one, then the optimization is delayed and the next step is 2910. If Flag\_Optimization 700 is one, then



the two dimensional array of size 5 by 20,000 called Expected\_Results\_Array 706 is initialized to zero in a For – Next loop established by 702, 704, 706, 708, and 710. Expected\_Results\_Array 706 will store the expected win rate, revenue, and gross profit, for a given mean price estimate and price.

5

FIG 8 illustrates the assignment of optimization variables. The size of the price increments between the lower and upper bounds of the range of Mean\_Price\_Est 800, as defined by the user's entry in FIG 2, field 202, is calculated in 800. The lower standard deviation is calculated and assigned to Standard\_Deviation\_Low 802. The upper standard deviation is calculated in and assigned to Standard\_Deviation\_High 804. The first Mean\_Price is calculated in 806. The value for Price\_Low\_Est 808 is assigned to Price\_Low 808. The value for Price\_High\_Est 810 is assigned to Price\_High 810.

FIG 9 begins the flow diagram of the Frequency Distribution Engine 118 referenced in FIG 1. The Frequency Distribution Engine 118 calculates an estimate of the distribution of market prices the menu 200 inputs describing the market. In the preferred embodiment of the Frequency Distribution Engine 118, the distribution is represented by a modified normal distribution such that the distribution to the left of the mean price is characterized by a normal distribution potentially having a standard deviation different than the distribution to the right of the mean. In this embodiment, the use of a modified normal distribution curve is computationally expedient. However alternative embodiments may employ other mathematical functions such as a Lagrange Polynomial. Yet another alternative embodiment may simply be a manual determination of a distribution of points.

25

FIG 9 illustrates the assignment of the optimization variables and the initiation of the Mean Price Error Loop defined by steps 902 through 1610. The value of Expected\_Results\_Start\_Index 900 is set to one. The Mean Price Error Loop defined by

steps 902 through 1610 is initiated by the For statement in 902. The value of mean price is calculated and assigned to Mean\_Price 904, which is recalculated for every repetition of the Mean Price Error Loop defined by steps 902 through 1610.

5           **FIG 10** illustrates the assignment of optimization variables and a continuation of the Mean Price Error Loop. **FIG 10** begins by determining the number of price increments represented by Price\_Increment 1000 contained in the range of the frequency distribution, as well as the number of increments from the low end to the mean price represented by Increments\_To\_Mean\_Price 1002. The values for variables Const1 1004  
10 and Const2 1006 are calculated. The value of Price 1008 is initialized. A programming loop 1010 to 1102 is established that increments Frequency\_Index 1010 in single steps to Increments\_To\_Mean\_Price 1010. The value of variable Price 1008 is stored in Supplier\_Price\_Index 1012. The Frequency Distribution for the given variable Price 1008 is calculated and stored in an array called Freq\_Dist 1014.

15

**FIG 11** illustrates the continued creation of the upper portion of the Frequency Distribution Array. The next value for the variable Price 1008 is calculated in 1100. The Frequency\_Index 1102 is increment and the instruction in the loop 1010 repeated until the value of Frequency\_Index 1010 is equal to Increments\_To\_Mean\_Price 1010  
20 plus one. Programming loop defined by steps 1104 through 1112 is established that increments Frequency\_Index 1104 from the value of Increments\_To\_Mean\_Price 1104 plus one in steps of one to 1000 inclusive. The Supplier\_Price\_Index 1106 array is set to the value contained in the variable Price 1106. The value for Freq\_Dist 1108 array is calculated. The value of Price 1110 is incremented by the value of Price\_Increment  
25 1110. The Frequency\_Index 1112 is incremented and the instructions in programming loop defined by steps 1102 through 1112 is repeated until the value of Frequency\_Index 1104 is equal to Increments\_To\_Mean\_Price 420 plus one.

**FIG 12** illustrates the smoothing of the Frequency Distribution Array data. The flow diagram that is the continuation of the Frequency Distribution Engine **118** referenced in **FIG 1** and relates to the normalization of the two halves of the distribution curve. The normalization begins with a determination **1200** of whether Const1 **1200** is larger than Const2 **1200**. If it the determination **1200** is true, then a programming loop defined by steps **1202** through **1206** is initiated where i **1202** is initialized to zero and incremented by one to a value of Increments\_To\_Mean\_Price **1202** plus one. The value stored in the array Freq\_Dist(i) **1204** is multiplied by the ratio of Const2 **1204** divided by Const1 **1204** and restored in Freq\_Dist(i) **1204**. Then the value of i **1206** is incremented and the loop defined by **1202** through **1206** repeated. If Const1 **1200** is not larger than Const2 **1200**, then the determination results in the End If **1208** statement.

**FIG 13** illustrates the continued smoothing of the Frequency Distribution Array and the determination of the Expected Results Array. If the determination **1200** is false, then a second determination **1300** of whether Const1 **1300** is less than Const2 **1300**. If the determination **1300** is true, then a programming loop **1302** through **1306** is established where i **1302** is initialized to a value of Increments\_To\_Mean\_Price **1302** plus one and stepped by increments of one. The value stored in the array Freq\_Dist(i) **1304** is multiplied by the ratio of Const2 **1304** divided by Const1 **1304** and restored in Freq\_Dist(i) **1304**. The value of i **1306** is incremented and the programming loop defined by **1302** through **1306** repeated. Once the programming loop defined by **1302** through **1306** is complete, a variable which represents the integrated value of the Frequency Distribution Array, Freq\_Dist\_Total **1310** is set to zero. If the determination of **1300** is false, then the routine proceeds to step **1310** where Freq\_Dist\_Total is set to zero.

The Probability of Win Engine **120** referenced in **FIG. 1** calculates the probability of a customer purchasing a subject good or service based on a factor called

Offer Opportunities. Specifically, Offer Opportunities define the number of customers that are exposed to a specific offer to sell said good or service at a designated price. The Probability of Win Engine 120 overcomes disadvantage of the prior art by eliminating the assumption that a good or service priced at a specific value will yield a predictable amount of sales regardless of the number of customers that were exposed to the specific offer to sell said good or service at a designated price. For programming expediency, the Probability of Win Engine 120 is embedded in the Expected Results Engine 122.

**FIG 14** shows the flow diagram that is part of the Expected Results Engine 122 referenced in **FIG 1**. The programming loop defined by steps 1400 through 1408 is used to integrate, or sum, the values defined by the first and last array element of the Frequency Distribution Array. The programming loop defined by steps 1400 through 1408 is initiated by setting Frequency\_Index 1400 to one and then incrementing in steps of one to 1000 for each loop. Frequency\_Index\_Less\_One 1402 is calculated. The variable Height 1404 is calculated by taking the average of two adjacent values of array Freq\_Dist 1404 for a given value of Frequency\_Index 1404. Freq\_Dist\_Total 1406 is calculated by multiplying the Price\_Increment 1406 by the Height 1406 and summing to the previous value of Freq\_Dist\_Total 1406. The next Frequency\_Index 1408 is calculated by incrementing Frequency\_Index 610 by one. The programming loop defined by 1400 through 1408 is repeated until Frequency\_Index 1400 equals 1001.

On completion of the programming loop defined by steps 1400 through 1408, the value of Expected\_Results\_Index 1410 is set to zero. The value of Expected\_Results\_End\_Index 1412 is calculated. The value of Frequency\_Index 1414 is set to one. The programming loop defined by 1416 through 1608 is established where the value of Expected\_Results\_Index 1416 is set to the value of

Expected\_Results\_Start\_Index **1416** and is incremented by one until Expected\_Results\_End\_Index **1416** is exceeded by a value of one.

**FIG 15** shows the continuation of the flow diagram that is part of the Expected Results Engine **122** referenced in **FIG 1**. The Price **1500** is stored in the Expected\_Results\_Array **1500** column zero. The Mean\_Price **1502** is stored in the Expected\_Results\_Array **1502** column one. The value for Frequency\_Index\_less\_One **1504** is calculated. The value for Cum\_At\_Price\_Rounded **1508** which represents the integral from the value Low\_End **306** to the current value of Price **1500** is calculated.

10 The value for Expected\_Results\_Array **1510** column two is calculated and depicts the probability of win with one competitor. The value for Expected\_Results\_Array **1512** column three is calculated and depicts the probability of win with for more than one supplier. The value for Expected\_Results\_Array **1514** column four is calculated and depicts the anticipated revenue for a specific price based on the number of offer

15 opportunities.

The incorporation of the number of suppliers in the market represents a significant advantage over prior art because there is not the assumption that the number of competitors at the time the yield curve was constructed remained the same.

20 Particularly in global markets, the number of competitors can change in a relatively short time frame which can potentially invalidate the yield curve. By quantifying and integrating the number of suppliers in the subject market, a more accurate and reliable determination of the optimum price can be made.

**FIG 16** shows the continuation of the flow diagram that is part of the Expected Results Engine **122** referenced in **FIG 1**. The value for Expected\_Results\_Array **1600** column five is calculated and depicts the anticipated gross profit for a specific price based the anticipated revenue and cost-of-goods. The value for

Expected\_Results\_Array 1602 column six is calculated and depicts the anticipated earnings before income tax. The value of Price 1604 is incremented. The value of Frequency\_Index 1606 is incremented. The value of Next\_Expected\_Results\_Index 1608 is incremented and the programming loop defined by steps 1416 through 1610  
5 repeated until Expected\_Results\_End\_Index plus one is reached.

**FIG 17** shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in **FIG 1**. **FIG 17** initiates the steps associated with identifying the first and last indexes of values contained in Expected Results Array  
10 corresponding to the current value Mean\_Price\_Est. As a result of potential rounding error, an uncertainty for Mean\_Price\_Est may be incorporated into the search. Flag\_Skip\_1 1700 is set to zero indicating that the first value of interest in a subsequent search has not been found. Flag\_Skip2 1702 is set to zero indicating that the second value of interest in a subsequent search has not been found. A programming loop  
15 defined by steps 1704 through 2000, is established to search the for the first index in the Expected Results Array where the value of Mean Price plus or minus a tolerance equals Mean\_Price\_Est. The For statement 1704 initiates the programming loop defined by 1704 through 2000. A determination of whether Flag\_Skip1 1706 is equal to zero is made. If Flag\_Skip1 1706 is not equal to zero, then step 1806 is executed. If  
20 Flag\_Skip1 1706 is equal to zero, then the value of Mean Price contained in the Expected\_Results\_Array 1708 is checked starting with the index value corresponding to Frequency\_Index 1708. If the Mean Price value is equal to Mean\_Price\_Est 1708, the program proceeds to the steps shown in **FIG 18**.

25 **FIG 18** shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in **FIG 1**. **FIG 18** illustrates the continued search in the Expected Results Array corresponding to the first index value of the array element Mean Price corresponding to the value stored in the variable Mean\_Price\_Est. If the value

corresponding to Mean Price contained in the Expected\_Results\_Array is equal to Mean\_Price\_Est, then the value of Start\_Index 1800 is set to Frequency\_Index 1800 plus one. Flag\_Skip1 1802 is set to one indicating that the index of the first Mean Price in Expected\_Results\_Array has been identified. A determination is made as to whether Flag\_Skip2 1808 is equal to zero. If Flag\_Skip2 1808 is not equal to zero, the last instance of the Mean Price in Expected\_Results\_Array has not been identified, and the program proceeds to the steps listed in FIG 19. If Flag\_Skip2 1808 is equal to zero, then a determination is made as to whether Frequency\_Index 1810 is equal to 20,000, and then the steps shown in FIG 19 executed.

10

FIG 19 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in FIG 1. FIG 19 illustrates the continued search in the Expected Results Array corresponding to the first and last index value of the array element Mean Price corresponding to the value stored in the variable Mean\_Price\_Est.

15 If the determination of Flag\_Skip2 1808 equal to zero is not true, then the If 1808 statement is terminated in step 1906. If the determination of Flag\_Skip 1808 equal to zero is true, then the determination of Frequency\_Index 1810 equal to 20,000 is made. If Frequency\_Index 1810 is equal to 20,000, then true, then the value of Frequency\_Index is assigned to the variable End\_Index 1900. Flag\_Skip2 1900 is set to one and the If 1810 statement is terminated in 1904. If the determination that Frequency\_Index is equal to 20,000 is true, then and value of Mean Price contained in the Expected\_Results\_Array 1908 is checked starting with the index value corresponding to Frequency\_Index 1908. If the Mean Price value is equal to Mean\_Price\_Est 1908, the program proceeds to store the value of Frequency\_Index less one in the variable End\_Index 1810. The variable Flag\_Skip2 1812 is set to one indicating that no further checking is necessary. If the Mean Price value is not equal to Mean\_Price\_Est 1908, the program proceeds to the End If 1814 statement.

20

25

**FIG 20** shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in **FIG 1**. **FIG 20** illustrates the search in the Expected Results Array for the price and corresponding index that yields the maximum income. The Next 2000 statement completes the programming loop defined by steps 1704 to

5    2000 associated with the search for the first and last index values of the array elements Mean Price corresponding to the value stored in the variable Mean\_Price\_Est. Temp1 2002 is assigned the first value of income in the Expected\_Results\_Array 2002 corresponding to the element pointed to by Start\_Index 2002. The corresponding price to the first value of income in the Expected\_Results\_Array 2004 is assigned to variable

10   Max\_Income\_Price 2004. A programming loop defined by steps 2006 through 2106 is established. The For 2006 statement will increment Frequency\_Index 2006 from Start\_Index+1 2006 to End\_Index 2006. Temp2 2008 stores the next array element in Expected\_Results\_Array depicting the projected income. A determination is made as to whether Temp2 2010 is larger than Temp1 2010, and if true, then Temp2 2012 is

15   assigned to Temp 1 2012 and the program proceeds to the steps shown in **FIG 21**. If the determination of whether Temp2 2010 is larger than Temp1 2010 is false, then the program proceeds to the steps shown in **FIG 21**.

**FIG 21** shows the continuation of the flow diagram that is part of the Expected

20   Results Engine 122 referenced in **FIG 1**. **FIG 21** illustrates the continued search in the Expected Results Array for the price and corresponding index that yields the maximum income. Max\_Income\_Price 2100 is set based on the first price entry in the Expected\_Results\_Array 2100. The Max\_Income\_Price\_Index 2102 is set to the current Frequency\_Index 2102. The End If 2104 statement terminates the If 2010

25   statement. The Frequency\_Index 2106 is incremented and the programming loop defined by steps 2006 through 2106 repeated until Frequency\_Index 2006 exceeds End\_Index 2006 by one.



After the programming loop defined by steps 2006 through 2106 is completed, the program begins the process of identifying the price representing the highest gross profit. Temp1 2108 is assigned the gross profit value in the Expected\_Results\_Array 2108 based on Start\_Index 2108. The price stored in the Expected\_Results\_Array  
5 corresponding to Temp1 2108 is stored in Max\_GM\_Profit 2110.

FIG 22 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in FIG 1. FIG 22 illustrates the continued search in the Expected Results Array for the price and index that yields the maximum profit. A programming loop defined by steps 2200 through 2300 is initiated by the For 2200  
10 statement. Frequency\_Index 2200 is stepped in increments of one starting with the value (Start\_Index+1) 2200 to End\_Index 2200. Temp2 2202 is assigned the value in Expected\_Results\_Array 2202 corresponding to profit pointed to by Frequency\_Index 2202. A determination is made in as to whether Temp2 2204 is larger than Temp1 2204. If the determination is not true, then the If statement is terminated in the End If  
15 2212 statement. If the determination is true, then Temp2 2206 is assigned to Temp1 2206. Max\_GM\_Price 2208 is assigned the value corresponding to price stored in the Expected\_Results\_Array 2208 pointed to by Frequency\_Index 2208. Max\_GM\_Price\_Index 2210 is assigned the current value of Frequency\_Index 2210. The Frequency\_Index 2300 is incremented by one and the programming loop defined by  
20 steps 2200 through 2300 repeated until the value of End\_Index 2200 is exceeded by one.

FIG 23 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in FIG 1. FIG 23 illustrates the determination of price so  
25 that the objectives of maximum income and profit are balanced. A determination of whether the variable Balance\_Choice 2302 equal to 0.5 is made. If the determination is not true, the program proceeds to the End If 2408 statement. If the determination is

true, then the user has specified the program optimize the selection of price by balancing the objectives of profit and income, and the program proceeds to step 2304.

5 A determination is made as to whether Max\_Income\_Price\_Index 2304 is greater than Max\_GM\_Price\_Index 2304. If the determination is not true, then the program proceeds to the End If 2308 statement. If the determination is true, then the program assigns Optimal\_Price\_Pointer 2306 with the value calculated by averaging the difference of index pointers Max\_GM\_Price\_Index 2306 and Max\_Income\_Price\_Index 2306 and summing Max\_GM\_Price\_Index 2306.

10

FIG 24 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in FIG 1. FIG 24 illustrates the continued determination of price so that the objectives of maximum income and profit are balanced. A determination of whether Max\_Income\_Price\_Index 2400 is greater than  
15 Max\_GM\_Price\_Index 2400 is made. If the determination is not true, then the program proceeds to the End If 2406 statement. If the determination is true, then the program assigns Optimal\_Price\_Pointer 2402 with the value calculated by averaging the difference of index pointers Max\_Income\_Price\_Index 2402 and Max\_GM\_Price\_Index 2402 and summing Max\_GM\_Price\_Index 2402. Optimal\_Price 2404 is assigned the  
20 value of price stored in Expected\_Results\_Array 2404 pointed to by the value stored in Optimal\_Price\_Pointer.

FIG 25 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in FIG 1. FIG 25 illustrates the assignment of variables  
25 if the objective is to maximize income. A determination is made as to whether Balance\_Choice 2500 is equal to one. If the determination is not true, then the If 2500 statement terminates in the End If 2506 statement. If the determination is true, then the

variable Optimal\_Price **2502** is assigned Max\_Income\_Price **2502**.

Optimal\_Price\_Pointer **2504** is assigned the value of Max\_Income\_Price\_Index **2504**.

5 A determination is made as to whether Balance\_Choice **2508** equals zero. If the determination is not true, then the If **2508** statement terminates in the End If **2602** statement. If the determination is true, then the variable Optimal\_Price **2510** is assigned the value stored in Max\_GM\_Price **2510**. Optimal\_Price\_Pointer **2600** is assigned the value of Max\_GM\_Price\_Index **2600**.

10 **FIG 26** shows the continuation of the flow diagram that is part of the Expected Results Engine **122** referenced in **FIG 1**. If the percentage difference in expected and actual win rates are outside a predefined window, a table that defines a relationship between the actual win rate, the current optimized price, and new mean price is used to update the optimization. **FIG 26** illustrates the steps used to determine the contents of the Error Lookup Array. A programming loop defined by steps **2604** through **2607** is initiated with the For **2604** statement, with i **2604** set to zero and stepped in increments of one to 19. The elements of Error\_Lookup\_Array(0,i) **2606** are populated with the value of Optimal\_Price **2606** based on index i. i **2607** is incremented and the programming loop defined by steps **2604** through **2607** repeated.

15 Error\_Lookup\_Array(1,0) **2608** is assigned the lowest Mean\_Price\_Est **2608** given the largest error as defined by Price\_Max\_Error **2608**. The value of Optimal\_Price\_pointer is assigned to Lowest\_Pointer **2610** and to Temp **2612**. A programming loop defined by steps **2614** through **2708** is established with the For **2614** statement, where i is set to zero and incremented by one to a value of 19.

25

**FIG 27** shows the continuation of the flow diagram that is part of the Expected Results Engine **122** referenced in **FIG 1**. Steps **2700** through **2710** find the lowest index to the optimal price for a given Mean Price. Temp **2700** is assigned a new value

determined by subtracting 1000 from the original value of Temp 2700. A determination of whether Temp 2702 is equal to, or greater than zero is made. If the determination is not true, then the If 2702 statement is terminated in the End If 2706 statement. If the determination 2702 is true, then Lowest\_Pointer 2704 is set equal to Temp 2704. i 2708 is incremented and the programming loop defined by steps 2614 to 2708 repeated. Error\_Lookup\_Array(2,0) 2710 is set equal to the value stored in Lowest\_Pointer 2710. The first index of the first Mean\_Price set is stored in Error\_Lookup\_Array(3,0) 2712 by setting it equal to one.

10       **FIG 28** shows the continuation of the flow diagram that is part of the Expected Results Engine 1220 referenced in **FIG 1**. The last index of the first Mean\_Price set is stored by setting the Expected\_Results\_Array(4,0) 2800 equal to 1000. A programming loop defined by steps 2802 to 2814 is initiated by the For 2802 statement, and populates the Error\_Lookup\_Array. The programming loop increments i 2802 from 1 to 19 in steps of one. The variable ii 2804 is calculated by subtracting one from i 2804. The value of Error\_Lookup\_Array(1,i) 2806 is calculated by adding the Price\_Max\_Error\_Increment 2806 to Error\_Lookup\_Array(1,ii) 2806. The value of Error\_Lookup\_Array(2,i) 2808 is calculated by adding 1000 to Error\_Lookup\_Array(2,ii). The value of Error\_Lookup\_Array(3,i) 2810 is calculated by adding 1000 to Error\_Lookup\_Array(3,ii) 2810. Error\_Lookup\_Array(4,i) 2812 is calculated by adding 1000 to Error\_Lookup\_Array(4,ii) 2812. i is incremented by one and the programming loop defined by steps 2802 through 2814 repeated.

25       **FIG 29** steps 2900 through 2910 shows the continuation of the flow diagram that is part of the Expected Results Engine 122 referenced in **FIG 1**. A programming loop defined by 2900 through 2906 is established by the For 2900 statement. i 2900 is set to zero and incremented in steps of one to 19. k 2902 is set equal to the value stored in Error\_Lookup\_Array(2,i). Error\_Lookup\_Array(5,i) 2904 is set equal to the value in

Expected\_Results\_Array(2,k) 2904. i is incremented by one and the programming loop defined by steps 2900 through 2906 repeated. A programming loop is established with steps 2907A through 2907C and is initiated by the For statement 2907A. i 2907A is set to zero and stepped in increments of one to 11000 plus one. The indexed array of  
5 Price\_Dist 2907B is set equal to Optimal\_Price 2907B. The programming loop 4607A through 4607C is repeated until 11000 plus one is reached. The value of Flag\_Optimization 2908 is set to zero indicating that the optimization is complete.

Step 2912 begins the flow diagram of the Optimization Update Engine 128  
10 shown in FIG 1. The decision whether to re-optimize pricing is based on a pre-determined number of offer opportunities and an evaluation of whether the percentage difference between the actual and expected win rates fall outside a predefined window. A determination of whether the arithmetic/logic expression (Competition MOD Optimization\_Update AND Competition) 2912 is greater than zero. If the  
15 determination 2912 is not true, then the If 2912 statement is terminated in the End If 3216 statement. If the determination 2912 is true, then the program proceeds to step 3000 indicating the actual results of the optimization should be checked. FIG 30 shows the continued flow diagram of the Optimization Update Engine referenced in FIG 1. Start\_Wins 3000 is set equal to Competition 3000 less  
20 Optimization\_Update 3000 plus one. End\_Wins 3002 is set equal to Competition 3002. Period\_Wins 3004 is set to zero. A programming loop defined by the steps 3006 through 3008 is initiated by the For 3006 statement. k 3006 is set equal to Start\_Wins 3006 and incremented in steps of one to a value equal to End\_Wins 3006. Period\_Wins 3007 is calculated by adding Actual\_Results\_Array(1,k) 3007 + Period\_Wins 3007. k  
25 is incremented by one and the programming loop defined by steps 3006 through 3008 repeated. Actual\_Wins\_Decimal 3010 is calculated by dividing the Period\_Wins 3010 by Optimization\_Update 3010. Expected\_Wins\_Decimal 3012 is set equal to Expected\_Results\_Array(2, Optimal\_Price\_Pointer) 3012. Temp 3014 is calculated by

taking the absolute value of the difference between Actual\_Wins\_Decimal 3014 and Expected\_Wins\_Decimal 3014, and then dividing the difference by Expected\_Wins\_Decimal 3014.

5           **FIG 31** shows the continued flow diagram of the Optimization Update Engine referenced in **FIG 1**. **FIG 31** illustrates the determination of whether the actual results are within a tolerable limit. A determination of whether Temp 3100 is greater than Error\_Window 3100 is made. If the determination 3100 is not true, then the If 3100 statement is terminated in an End If 3210 statement. If the determination 3100 is true, then Win\_Difference\_Current 3102 is calculated by taking the absolute value of the difference between the Actual\_Wins\_Decimal 3102 and the Error\_Lookup\_Array(5,0) 3102. A programming loop defined by steps 3104 and 3204 is initiated with the For 3104 statement. i is incremented from one to 19 in steps of one. Win\_Difference\_Current 3106 is calculated by taking the absolute value of the difference between the Actual\_Wins\_Decimal and Error\_Lookup\_Array(5,i) 3106. A determination of whether Win\_Difference\_Lowest 3108 is greater than Win\_Difference\_Current 3108 is made. If the determination 3108 is not true, then the If 3108 statement is terminated in an End If 3202 statement. If the determination 3110 is true, then Win\_Difference\_Lowest is set equal to Win\_Difference\_Current 3110.

20

**FIG 32** shows the continued flow diagram of the Optimization Update Engine referenced in **FIG 1**. **FIG 32** illustrates the selection of a new mean price. Win\_Difference\_Lowest\_Index 3200 is set equal to i. i is incremented by one and the programming loop defined by steps 3104 through 3204 is repeated. New\_Mean\_Price\_Est 3206 is set equal to Error\_Lookup\_Array(1, Win\_Difference\_Lowest\_Index) 3206. The variable Use\_New\_Mean\_Price\_Est is set equal to one. Mean\_Price 3212 is set equal to Expected\_Results\_Array(1,

Win\_Difference\_Lowest\_Index) 3212. The variable Flag\_Optimize 3214 is set equal to one.

The incorporation of a method to rapidly detect when to update the price optimization is a significant advancement over prior art. Since prior art does not include metrics related to Offer Opportunities and Probability of Win, knowing when to conduct an update of price optimization was a matter of qualitative professional judgment as opposed to a quantitative determination based on statistical principles of sampling theory.

In addition to detecting when an update of price optimization is needed, using the actual win rate as a way of re-optimizing the price is a significant advancement over prior art. Unlike prior art that requires reformation of the demand curve by selling the subject good or service at various prices, this embodiment uses the actual win rate and current price to eliminate the need for test selling. Rather, the actual win rate is used to reformulate the Frequency Distribution, recalculate the Probability of Win, determine the new Expected Results, and select the optimal price.

The combination of detecting when to update the optimization and the method of re-optimizing allows this embodiment to produce more accurate price optimizations one to two orders of magnitude faster than prior art.

**FIG 33** illustrates the flow diagram that represents the Interface to Legacy Systems 124 shown in **FIG 1**. The subroutine Get\_New\_Competition\_Count 3300 extracts the number of competition for a given time period from the Legacy System(s) 126 and assigns the value to the variable Competition 3300. The subroutine Get\_Actual\_Wins 3302 extracts the number of sales for a given time period from the

Legacy Systems(s) 126 and assigns it to the variable Actual\_Wins 3302. The program then loops back to step 608.

The present embodiment provides a superior computer implemented method for continuously pricing goods and services so that certain business objectives are met. The technique overcomes the three principal challenges of the prior art. In addition, the present embodiment adds a significant enhancement that mitigates the uncertainty in implicit assumptions associated with the prior art.

The method begins by a user creating an estimated Frequency vs. Price distribution curve for the subject market. This curve represents the user's estimate of the frequency of competitor's offers at each price for similar goods and services.

The Frequency vs. Price distribution curve is converted to a Probability of Win vs. Price curve by integrating the area under the Frequency vs. Price distribution curve. The Probability of Win vs. Price curve is adjusted based on the number of competitors. Using the Probability of Win vs. Price curve, the number of units sold can be predicted based on a number of offer opportunities. Offer opportunities are the instances in a given time period that a supplier has to sell their goods or services. How offer opportunities are quantified may differ from industry-to-industry. For example, an industrial distributor [supplier] may sell their goods through a request-for-quote/bid model. Offer opportunities in this instance consist of the number of bids the distributor submitted to potential customers in a given time period. Another example is a grocer. If the grocer wanted to understand the market's responsiveness to a particular type of cereal, the offer opportunities could be defined as the number of overall sales for all cereals.



As with the prior art, using the understanding of the relationship between quantity and price, an income statement, as well as additional metrics, can be constructed for each price through the following steps; a) Calculation of revenue by multiplying the price and quantity, b) Determination of the cost-of-goods by multiply  
5 the quantity and unit cost at that quantity, c) Calculation of gross profit by subtracting the cost-of-goods from the revenue, d) Determining the sales and general administration costs, e) Calculating the earnings before income tax by subtracting the sales and general administration costs from the gross profit, f) Calculation of market share by dividing the quantity by the total quantity sold by all suppliers, and e) Calculating factor utilization  
10 by dividing the units sold by the capacity of the factory for that product. Once the income statement and additional metrics are calculated for each price, the optimum price can be selected to satisfy one or more business objects.

Market shifts due to changes in demand or shifts in one or more competitor's  
15 pricing are detected by comparing the expected probability of win verse the actual win rate at a given price. If the actual and expected win rates differ outside of a predefined window of acceptability, then an optimization update is initiated.

If an optimization is merited, the method uses the difference between the  
20 expected and actual win rate to determine how the frequency distribution curve should be altered. The probability of win curve is then recalculated, the process of computing an income statement for each price repeated, and the appropriate price selected based on the optimization.

25 The creation of the Frequency Distribution and Probability of Win curves solves the four challenges of the prior art and substantially mitigates the uncertainty of implicit assumptions in the following ways:

- a) Provides a complete representation of a market's responsiveness to pricing rather than the limited view provided by the supplier's historical sales orders.
- 5 b) Overcomes the absence of statistically relevant data that hinders the rendition of a demand curve.
- c) Ensures market relevancy by using an expert's view of the market rather than relying on historical sales order data that may not be relevant in predicting the market's responsiveness.
- 10 d) Mitigates the weight on the assumption that the market remains the same by creating a metric called offer opportunities through which sales opportunities may be gauged.

The fifth and sixth challenges of prior art, rapidly determining when an optimization is needed and updating the optimization are solved in the following ways:

- 15 a) Provides a method for rapid detection of when optimization is no longer relevant based on the difference between actual and expected win rate.
- b) A method for rapidly updating the optimization by using the difference between actual and expected win rate in determining a new more
- 20 representative Frequency Distribution curve for the subject market.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. For example, any of the network elements may employ any of the desired functionality set forth

25 hereinabove. Thus, the breadth and scope of a preferred embodiment should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.